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**PATENT APPLICATION**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

EDMONDS

Group Art Unit: 2875

Application No.: 10/785,480

Examiner: Unknown

Filed: February 25, 2004

Attorney Dkt. No.: 1232.002

For: METHODS FOR PRODUCING THREE DIMENSIONAL SELF-SUPPORTING, LIGHT REDIRECTING ROOF LIGHTING SYSTEM

**SUBMISSION OF PRIORITY DOCUMENT**

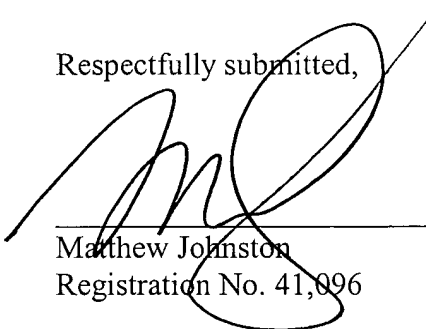
Commissioner for Patents  
Washington, D.C. 20231

May 24, 2004

Sir:

Applicant hereby submits certified priority document 2003/252881 filed October 10, 2003 in Australia.

Respectfully submitted,

  
Matthew Johnston  
Registration No. 41,096

LINIAK, BERENATO & WHITE  
6550 Rock Spring Drive  
Suite 240  
Bethesda, Maryland 20817  
Telephone: (301) 896-0600  
Facsimile: (301) 896-0607



**Patent Office  
Canberra**

I, LEANNE MYNOTT, MANAGER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Complete specification in connection with Application No. 2003252881 for a patent by IAN ROBERT EDMONDS as filed on 10 October 2003.

WITNESS my hand this  
Twelfth day of March 2004

A handwritten signature in black ink, appearing to be "LM", written over a horizontal line.

LEANNE MYNOTT  
MANAGER EXAMINATION SUPPORT  
AND SALES

# METHOD FOR PRODUCING A THREE DIMENSIONAL, STRUCTURALLY SELF-SUPPORTING, ANGLE-SELECTIVE ROOF LIGHT.

## BACKGROUND TO THE INVENTION.

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The basic form of roof lighting system is an aperture in the roof that connects via a reflective well to an aperture in the ceiling of the room below. Natural light passing through the system provides natural illumination to the room below. This basic form of roof lighting system is ineffective in accepting and transmitting low elevation sunlight to the room below. Thus natural illumination via roof lights tends to be poor in the early morning and late afternoon and in winter when the sun is at low elevation angle. Conversely, this basic form accepts and transmits high elevation light very effectively. However this may lead to overheating of the room below during the middle of the day in summer when the sun is at high elevation angle. It is therefore desirable to have a means of increasing the acceptance and transmittance of a roof lighting system when the sunlight elevation angle is low and decreasing the acceptance and transmittance when the sunlight elevation is high thereby providing the roof lighting system with an angle selective acceptance function. A first objective of this invention is to provide a method for producing a roof light with an angle selective acceptance and transmittance function.

Angle selective lighting systems may be formed from panels of light deflecting material such as laser cut light deflecting material, hereafter referred to as laser cut panel or LCP. LCP is produced by making a parallel array of laser cuts through or partly through planar sheets of clear plastic. The surface of each laser cut becomes a small reflecting mirror inside the panel

that strongly deflects light as it passes through the panel. The method for producing laser cut light deflecting material is described in AU 601634 and US 4,989,952.

Simple geometric configurations of laser cut panels can be designed to provide useful forms of angle selective light transmission such that the light transmission of the system varies depending on the direction or angle of incidence of light on the system. Angle selective light transmission can be used to enhance the performance of lighting systems, both electrical lighting systems and natural lighting systems. As an example of the improved performance of a natural lighting system consider the roof lighting system illustrated in Fig 1. Here two laser cut light deflecting panels 1 and 2 are placed in a triangular or saddle configuration above a roof lighting aperture 3. Light ray 4 that would otherwise pass above aperture 3 is deflected by LCP 1 down through roof aperture 3 and transmitted into the building. This enhances the performance of the roof light for low angle light. Light ray 6 from directly above is deflected from LCP 1 across to LCP 2 and deflected by LCP 2 back out of the roof lighting system. This reduces the transmission of high angle light through the roof lighting system to the room below. This is often useful to reduce overheating through roof lights near the middle of the day in summer that can amount to one kilowatt per square metre of roof light.

The LCP may also be formed into multi-faceted configurations such as pyramidal - as in Fig 2 - pentagonal, octagonal and so on. Such configurations of LCP have a similar angle selective function as described for the saddle configuration of Fig 1. That is the systems tend to enhance the transmission of low angle light while reducing the transmission of high angle light. Such angle selective systems are useful in the design of roof lighting systems and in the design of electrical lighting systems or luminaires.

Currently, such roof lighting systems for use in buildings are formed from separate flat panels of LCP, cut to the appropriate shape, and fixed together in the desired geometrical configuration by metal brackets or other means. This is cost effective for large roof lighting systems with apertures about one square metre or larger. However the assembly cost is prohibitive for smaller roof lighting systems of the type associated with light pipes and for light distribution systems associated with electrical lights.

Thus it is a second objective of this invention to provide a method for producing a self-supporting, three dimensional structure of laser cut light deflecting material. The three dimensional structure may be of saddle or pyramidal or any multifaceted three dimensional form suited to angle selective light acceptance and transmission.

#### SUMMARY OF THE INVENTION.

The method of this invention is to cut a series of laser cut arrays in a single flat sheet of clear plastic. Each array of laser cuts in the flat panel being associated with a individual facet of the desired geometrical configuration of the angle selective roof lighting system and each array of laser cuts being separated from neighbouring arrays by a narrow strip of clear plastic left uncut and solid. One of the narrow solid strips separating two of the individual laser cut arrays in the resulting laser cut flat sheet is then softened by heating. When sufficiently softened the plastic is folded through the appropriate angle along the line between the two laser cut arrays and then allowed to cool to below the softening temperature. This results in a rigid joint between the two facets of the desired geometrical configuration with each facet containing an array of laser cuts. The procedure of softening, folding and cooling is repeated

for each narrow strip between the facets until a solid three-dimensional structure of the required form is obtained.

#### BRIEF DESCRIPTION OF THE DRAWINGS.

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Fig 1. Illustrates how two laser cut light deflecting panels may be placed in a triangle, gable or saddle configuration above a roof aperture to provide a roof lighting system with an angle selective light function accepting low angle light and rejecting high angle light.

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Fig 2. Illustrates how four laser cut light deflecting panels may be placed in a pyramidal configuration to provide a roof lighting system with an angle selective light function accepting low angle light and rejecting high angle light.

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Fig 3. Illustrates the method of producing an saddle form of angle selective roof lighting system by making two arrays of parallel laser cuts in a flat panel of clear plastic, softening the narrow clear plastic strip between the arrays with a strip heating element, and folding the panel and allowing it to cool and solidify so as to form a self supporting angle selective roof lighting system.

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Fig 4 Illustrates a typical pattern of the arrays of laser cuts to be made in a clear plastic sheet and the pattern of the segment of flat panel to be cut from the plastic sheet prior to softening the region of the segment along the lines between the arrays, and folding and cooling so as to form an angle selective roof lighting system of pyramidal form.

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#### DETAILED DESCRIPTION OF THE INVENTION.

The method of this invention for producing the simplest triangular, gable or saddle form of angle selective lighting system is described with reference to Fig 3. Fig 3 (a) shows a flat rectangular plastic sheet with two arrays of parallel laser cuts 1 and 2 made through two sections of the flat sheet. A narrow strip solid plastic 10 is left between the two arrays of laser cuts 1 and 2. The laser cuts may penetrate right through the sheet, or, may be cut partly through the sheet so that one side of the sheet remains solid. Typical depth of the laser cuts would be 6 mm and typical spacing between each laser cut in each array of parallel cuts would be 4 mm. The flat plastic sheet with the two arrays of cuts is then placed on a table 11 which has a long, thin heating element 12 incorporated in a slot in the table 11. The heating element is powered by a variable electric power source 13. There may be pipes containing water coolant running on either side of heating element 12 to narrow the width of the strip of plastic sheet being heated. The flat plastic sheet is placed on the table above heating element 12 such that the narrow solid strip 10 between the laser cut arrays is heated to the softening temperature of the plastic. One section of the flat sheet is then folded upwards through the required angle and the folded joint allowed to cool until solid. This results in a self supporting three dimensional structure of saddle form as in Fig 3 C.

The application of the method of this invention to the production of a self-supporting pyramidal angle-selective lighting system is now described with reference to Fig 4 and Fig 5. Fig 4 shows the pattern of the segment to be cut from a flat plastic sheet in order to form a pyramidal angle selective lighting system. Arrays of laser cuts 15, 16, 17 and 18 are cut in adjoining regions of the segment with an automatic laser cutting machine, the cuts extending partly or right through the sheet. The resulting segment is then removed from the sheet and placed on a table fitted with a linear heating element as in Fig 3 and softened, folded and



cooled sequentially at lines 19, 20 and 21 between the individual laser cut arrays resulting in the self supporting pyramidal structure illustrated schematically in Fig 5.

5 When many roof lighting systems of the types described are to be produced the production rate according to the method of this invention may be increased by having multiple line heating elements fixed in a table in the desired configuration such that each line of the piece could be heated to the softening temperature simultaneously and with subsequent foldings made simultaneously over a mould of the appropriate shape.

10 When multi-faceted structures are made by the method of this invention the resulting self supporting structure has two adjoining edges that are not solidly joined together. Provided the plastic material of the structure is of reasonable thickness, for example 6 mm, and the spatial extent of the facets is not too large, for example less than 1 m wide, then the structure so formed is stable and self supporting. However, it may be desirable to join the two edges  
15 with plastic adhesive or some other means in order to maximise structural stability and strength.

Those modifications and equivalents which fall within the spirit of the invention are to be considered a part thereof.

I claim:

(1) A method for producing a multifaceted, three dimensional, structurally self supporting  
5 angle selective roof lighting system comprising:

(a) making two or more arrays of parallel cuts in a flat sheet of clear plastic with narrow strips  
of solid clear plastic being left uncut between adjoining arrays of laser cuts, said arrays of  
parallel cuts covering a segment of said flat sheet such that the removal of said segment of  
10 flat sheet and the folding of said segment of flat sheet along the lines of the narrow solid  
strips between each array of fine parallel cuts in the segment would result in a multifaceted,  
three dimensional structure of saddle, pyramidal or higher order form;

(b) cutting and removing said segment out of said flat sheet;

(c) positioning said segment on a table such that one of the narrow strips of solid clear plastic  
between the arrays of cuts is aligned directly above a narrow linear heating element slotted  
into the surface of said table;

(d) applying electrical power to said linear heating element such that the narrow strip of solid  
20 plastic between adjoining arrays of cuts in said segment is softened;

(e) folding said segment along the line of the narrow strip which has been softened through  
an angle suited to the formation of the required three dimensional structure then allowing the  
25 narrow strip of plastic to cool and solidify;

(f) repeating the procedure of steps (c), (d) and (e) for each narrow strip of solid plastic between adjoining arrays of cuts so as to form a multi-faceted, three dimensional, self supporting angle selective roof lighting system.

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(2) a method as in claim 1 in which the segment is first cut from the flat sheet of clear plastic and the arrays of cuts are subsequently cut in the segment.

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(3) a method as in claim 1 or 2 in which the cutting of the arrays of parallel cuts and the cutting of the segment from the flat sheet of clear plastic is performed by a laser cutting machine.

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(4) a method as in claim 1 or 2 in which the cutting of the arrays of parallel cuts and the cutting of the segment from the flat sheet of clear plastic is performed by a water cutting machine.

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(5) an angle-selective roof lighting system as in claim 1 or 2 positioned in an aperture in the roof of a building to increase the acceptance and transmittance of low elevation light to rooms below and to reduce the acceptance and transmittance of high elevation light to rooms below.

Ian Robert Edmonds

8 th October 2003.

□

## ABSTRACT

A three dimensional structurally self-supporting angle-selective roof lighting system may be produced by making a number of adjoining arrays of laser cuts through, or partly through, a flat sheet of clear plastic. The segment of the flat sheet containing the arrays of cuts is positioned over a linear heating element to soften the plastic along the line between adjoining arrays. The segment is folded along the line and allowed to solidify. The softening and folding of the segment is repeated to form a self-supporting multi-faceted structure such as a pyramid with an array of light deflecting laser cuts on each facet of the structure. A pyramidal arrangement of laser cut arrays provides a roof light that accepts and transmits low elevation light and rejects high elevation light.

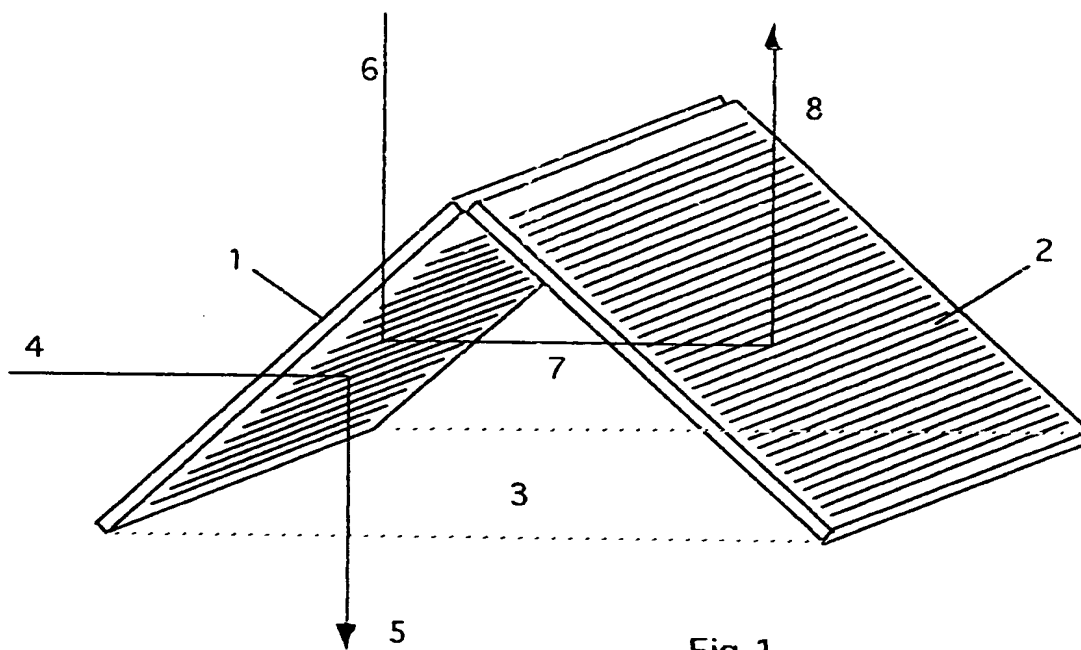


Fig 1

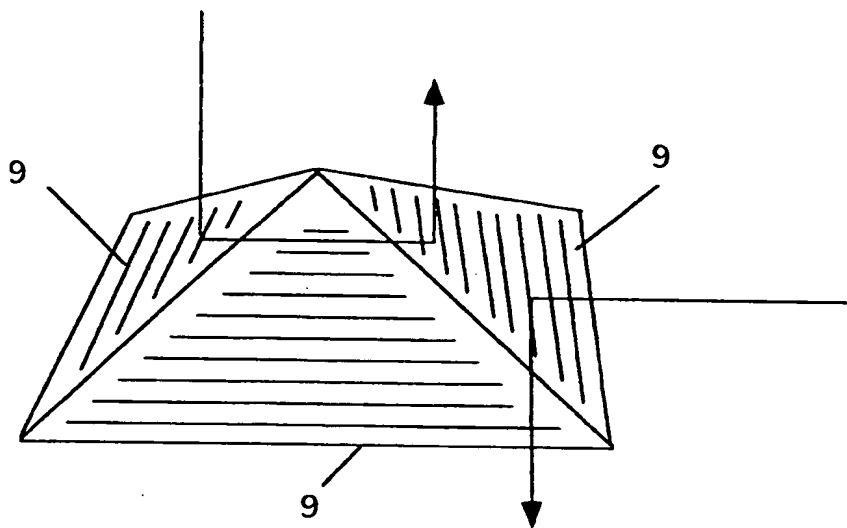
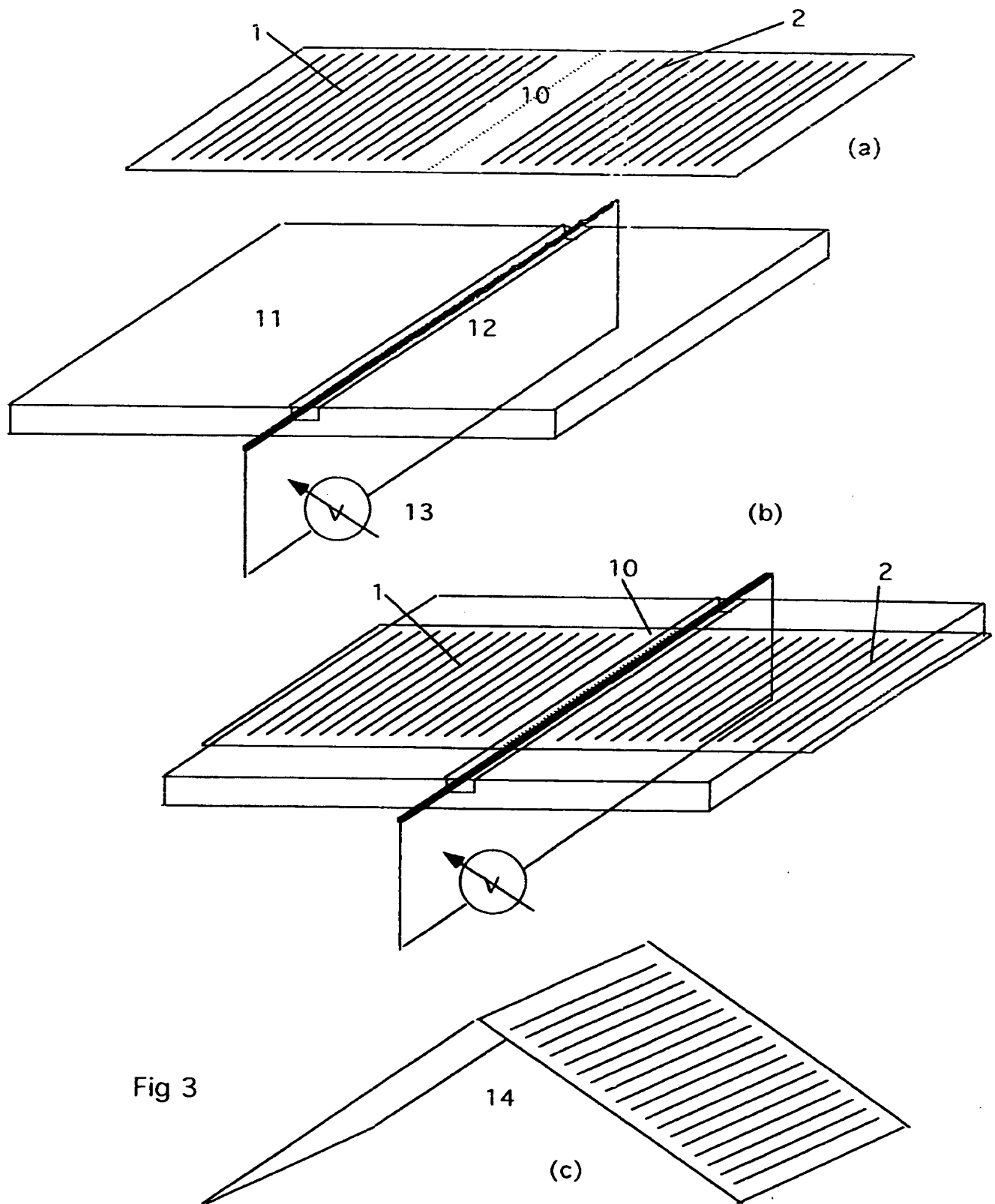


Fig 2



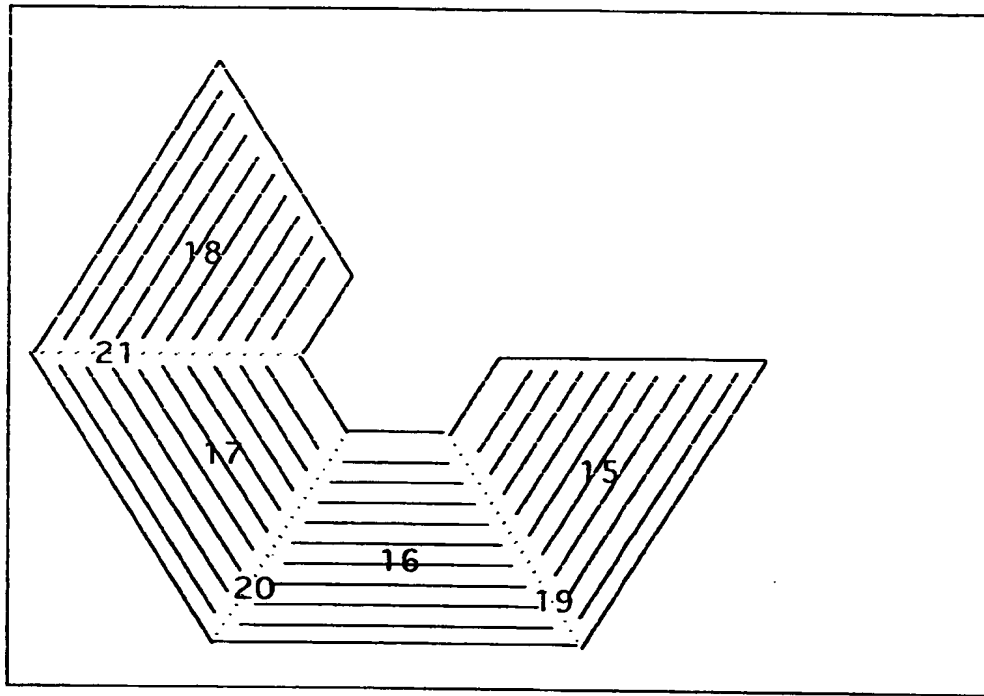


Fig 4

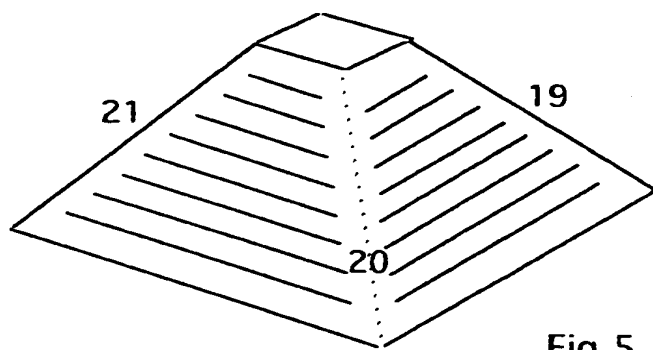


Fig 5